Chemistry Comes Alive

Karen Benn Marshall
Associate Professor
Montgomery College
Takoma Park Campus

Part I: Basic Chemisry

Definitions

- matter (anything)
  - occupies space
  - has mass
- energy
  - capacity to do work
    - puts matter into motion

Definitions

- element
  - substance
    - cannot be broken down into simpler substances by ordinary chemical means
    - O, C
- atoms
  - building blocks (particles) of which elements are made

Definitions

- molecule
  - combination of 2 or more atoms (H_2)
    - held together by chemical bonds
  - smallest particle of a cpd that has specific characteristics
- molecule of the element
  - if 2 or more atoms of the same element combine

Definitions

- compound (cpd)
  - when 2 or more different kinds of atoms bind
    - H_2O, CH_4
- chemical bond
  - energy relationship
    - between electrons of the reacting atoms

Definitions

- ion
  - atom w/ + or - electric charge
  - charged particle

Reactions (rxns)

- chemical
  - results of bond formation
    - rearrangement
    - breakage
  - written in symbolic form as chemical equation

Reactions (rxns)

- anabolic
  - energy-requiring building up rxns of metabolism
  - combine simpler to form complex substances

Reactions (rxns)

- catabolic
  - substances broken down into simpler ones
  - type of metabolic rxn
- exergonic
  - release energy
  - yield products w/ less energy than initial reactants

Reactions (rxns)

- endergonic
  - absorb energy
  - yield products w/ more potential energy than intial reactants

Energy Flow in Chemical Reactions

- all chemical bonds represent stored energy
- all chemical rxns result in
  - net absorption (exergonic)
  - release of energy (endergonic)

Temperature

- factor that influences the rate of the chemical rxn
- increase
  - ↑ particle KE
  - ↑ force of collisions
  - faster proceeding rxn
- decrease
  - ↓ particle movement
  - slower proceeding rxn

Definitions

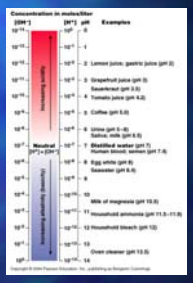
- electrolyte
  - chemical substance
    - salt, acid, base
  - ionizes in H_2O
  - capable of conducting an electric current
- acids
  - release H^+
  - proton donors
    - determines acidity of a solution

Definitions

- bases
  - proton acceptors
  - release OH^- and cations
    - produces H_2O
    - ↓ acidity
- pH [acid-base]
  - measure of $[H^+]$ of a solution
    - moles/l
    - neutral=7; alkaline=above 7; acidic=below 7
    - normal blood pH = 7.35-7.45

pH Scale

- based on $[H^+]$ in sol
- expressed in moles/l
- 0 - 14
- pH of 7
  - $[H^+]=[OH^-]$
  - neutral sol
- logarithmic



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Definitions

- buffer
  - chemical substance or system
  - minimizes pH changes
    - releases H^+
      - when pH rises
        - acts as acid
    - binds H^+
      - when pH drops
        - acts as base
    - prevents excessive pH changes

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Part II: Biochemistry (Organic Compounds)

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Carbohydrates

- group of molecules
  - sugars, starches
- contain C, H, O
- classified according to size and solubility
  - three types
    - monosaccharides
    - disaccharides
    - polysaccharides

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Carbohydrates

- monosaccharides ~ simple sugars
  - one sugar molecule
    - glucose, fructose, galactose
  - structural units ~ building blocks of other CHO
- disaccharides
  - two sugar molecules
    - sucrose=glucose + fructose
- polysaccharides
  - many sugars
    - starch, glycogen

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Carbohydrates

- provide a ready, easily used source of cellular fuel *(major function)*
- breakdown & oxidation of glucose
  - transfer of electrons
    - relocation of electrons → release of energy stored in glucose
      - energy used to synthesize ATP
- storage of dietary CHOs
  - conversion to glycogen or fat
    - enough ATP

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Cellular Respiration

- metabolic process
- ATP production
- major pathway by which glucose is broken down for energy in body cells
- $C_6H_{12}O_6 + O_2 \rightarrow 6CO_2 + 6H_2O +$ ATP
  - $C_6H_{12}O_6$ oxidized to CO_2
    - as it loses H atoms
  - O_2 reduced to H_2O
    - as it accepts H atoms

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Cellular Respiration Process

- oxidation-reduction rxn (redox)
- consists of two kinds of rxns
  - decomposition rxns
  - exchange rxns

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Chemical Respiration Process

- decomposition rxns
  - basis of all rxns in which food fuel are catabolized for energy
  - ATP production
- exchange rxns
  - electrons exchanged between reactants
  - reactant loses electrons
    - electron donor (oxidized)
  - reactant gains electrons
    - electron acceptor (reduced)

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Lipids

- diverse
  - neutral fats
  - phospholipids
  - steroids
  - other lipoid substances
- contain C, H, O
- insoluble in H_2O
- soluble
  - other lipids
  - organic solvents
    - alcohol or ether

Functions of Lipids (Table 2.2)

- chief component of CM
- protect and insulate body organs
- major source of stored energy
- necessary for normal bone growth and function

Proteins

- contain C, O, H, N
  - many also contain S, P
- comprise 10-30% cell mass
- basic structural material of body
- includes enzymes, Hgb, muscle contractile proteins
- most varied functions
- building blocks
  - a.a
    - ~20 common types

Proteins

- classification
  - overall apperance
  - shape
    - two types
      - fibrous
      - globular

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Proteins

- fibrous ~ structural proteins
  - extended and strandlike
  - insoluble in H_2O
  - stable
    - mechanical support (body tissues)
    - tensile strength
  - chief building materials of body
  - most exhibit only 2^o structure
    - collagen, keratin, elastin, actin, myosin

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Proteins

- globular ~ functional proteins
  - compact
  - spherical proteins w/ tertiary structure
    - some quaternary
  - H_2O soluble
  - chemically active
    - play crucial role in biological processes
  - provide immunity (AB)
  - regulate growth and development
  - some act as catalysts

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Protein Denaturation

- extreme T or pH changes
- ↓pH and ↑T
  - H bonds break
- changes above physiological levels
  - protein unfolds and loses 3D shape
    - protein denatured
- very extreme T or pH changes
  - structure damaged beyond repair
    - irreversibly denatured

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Irreversible Denaturation

- condition of globular proteins
- no longer able to perform physiological function (fnc)
  - fnc dependent on presence of specific arrangement of atoms (active site)
- ex. coagulation of egg white (albumin protein)

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Enzymes

- globular proteins
- act as biological catalysts
- ↑chemical rxn rate
  - by more than a millionfold
  - ↓amt of activation energy required

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Enzymes

- various types
  - purely protein
  - consist of two collective parts
    - holoenzyme
      - an apoenzyme (protein part)
    - cofactor
      - ion (Cu^{2+} or Fe^{2+})
      - organic molecule
        - most derived from vitamins (vitamin B complex)
        - AKA coenzyme

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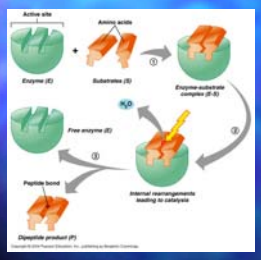
Mechansim of Enzyme Activity (fig 2.21)



- Three basic steps
- 1) E binds w/ S ⟶ formation of E-S complex
  - S binding causes active site change shape
    - induced fit model
- 2) E-S complex undergoes internal rearrangement ⟶ product
- 3) E releases P
  - Summary
- E+S → E-S → P+E

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Nucleic Acids

- composed of C, O, H, N, P
- largest molecules in the body
- structural units
  - nucleotides
    - 3 components
      - nitrogen-containing base
      - pentose sugar
      - phosphate group
- 2 major classes
  - deoxyribonucleic acid (DNA)
  - ribonucleic acid (RNA)

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DNA

- nucleus
- constitutes the genetic material (genes)
- long double-stranded polymer
- roles
  - replicate (reproduce) itself before a cell divides
  - provide instructions for building every protein in the body
    - determines what type of organism you will be

RNA

- cytoplasm
- single strands of nucleotides
- carries out the genetic instructions for protein synthesis

Adenosine Triphosphate (ATP)

- universal energy compound of body cells
- captures energy liberated by the breakdown of glucose and other fuels